Telephone: [redacted]
Telegrams: [redacted]

JOHN W[redacted]

287, [redacted]

Instrument Maker [redacted]
[redacted]

CONTRACTORS TO [redacted]
Special Optical and Scientific [redacted]

OPERATION & PROJECTION LA[redacted]

(Prov. Patent [redacted])

As an operation lamp [redacted] suitable for ophthalmic work, as an [redacted] light of 40 c.p., without shadows, [redacted]

For examination of the [redacted]

The tube is provided with [redacted] projection on to a screen. [redacted] spring gate is supplied by which [redacted] different optical system and an [redacted] magnification of 50 diameters at [redacted]

A transilluminating cone and [redacted]

Prices from £7 10 [redacted]

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COMMUNICATIONS

ENDOTHELIOMA OF THE OPTIC NERVE

BY

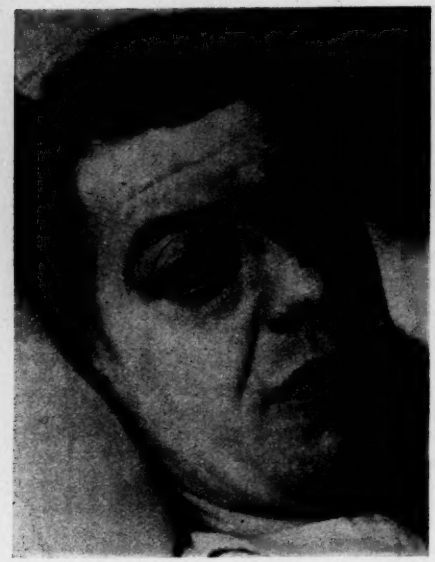
HUMPHREY NEAME AND EUGENE WOLFF

Clinical Report by E. Wolff

F.H., a man, *aet.* 27, came under the care of Sir J. H. Parsons, to whom acknowledgments are made for permission to report the case, at University College Hospital in March, 1924. He stated that for the last six years his right eye had been growing more prominent.

On examination the eye was found to be proptosed to a marked degree (see Figs. 1 and 2). The proptosis was straight forward. All movements were somewhat limited and rather worse upwards. On palpating between the orbital margin and the globe a firm lobulated mass could be felt all round the eyeball and fixed to it. The right pupil was larger than the left and reacted sluggishly to light directly, but was brisk to consensual illumination.

R.V.—He could only "count fingers" at a metre with his right eye, but the retinoscopy showed him to be hypermetropic to the extent of 7.5D. With this correction he read 6/36. The hypermetropia definitely increased while he was under observation, and was presumed to be due to flattening of the globe by a tumour pressing on it behind. The right fundus showed a papilloedema of 3-4D. and, a very curious feature of the case, there was some scattered black pigment down and out from the disc (see Fig. 3). This latter was most probably due to interference with the short



FIGS. 1 and 2.

Photograph of patient, showing proptosis of right eye.

FIG. 3.

Drawing of fundus, showing blurring of disc margin, congestion of disc, and marked arching forwards of the retinal vessels.

ciliary arteries; for it has been shown that tying these vessels in the rabbit produces a similar condition. The left eye was emmetropic; the fundus normal and the vision 5/5.

An X-ray examination of the orbit and accessory sinuses of the nose showed nothing abnormal. The Wassermann reaction was negative. Nothing abnormal was felt in the renal fossae.

A diagnosis of tumour of the optic nerve was made. On March 31, 1924, an operation for the removal of the tumour was done under general anaesthesia. The conjunctiva was incised all round close to the limbus and dissected up.

The external rectus was divided and a finger put into the orbit to determine the extent of the growth. Local excision was found impossible and after the external canthus had been slit up the eye and the tumour adhering to it were removed as one.

There was no recurrence ten months later.

Pathological Report by Humphrey Neame

F.H., March 31, 1924. Pathological O.P., No. 1628, Royal London Ophthalmic Hospital.

Macroscopic examination.—The specimen, in 10 per cent. formaldehyde, consisted of eyeball and an ovoid mass firmly attached to the posterior part of the globe and partly enveloping it. The posterior surface of the mass showed a flat surface, approximately circular and of 18 mm. diameter, with the cut surface of the optic nerve near the centre of this surface. A slice was removed from the posterior end of the mass, 5 mm. in thickness, and transferred to Müller's fluid, for a period of over six weeks, with several changes of fluid during that time, during which the fluid was kept warm on a paraffin-embedding chamber. The specimen was divided, after freezing, into three parts horizontally, the central portion including all the optic nerve. The cut surface showed the ovoid mass to be attached to the outer surface of the sclera for about 1/3 of the total circumference of the eyeball. The cut surface of the remainder of the mass measured 22 mm. antero-posteriorly, from immediately behind the sclera at the posterior pole to its posterior limit. The greatest transverse diameter was 29 mm. The surface of the mass was homogeneous and of a yellow-white colour. A few red-brown spots and flecks and some thin fibrous strands were visible. The Müller-fixed tissue was embedded in paraffin and stained: (1) with glychaemalum and eosin; (2) with Weigert's iron haematoxylin and van Gieson's picric acid fuchsin; (3) with Weigert-Pal's method of showing medullary sheath. The main central horizontal slice was embedded in celloidin and serial sections cut of the optic nerve portion. These were stained with glychaemalum and eosin, and with Weigert's iron haematoxylin and van Gieson's stain.

Sections stained by the Weigert-Pal method show the uniform presence of medullary sheath throughout in this posterior part of the optic nerve.

Serial celloidin sections.—Stain, glychaemalum and eosin, Weigert's iron haematoxylin, and van Gieson's as above. Between fifty and sixty serial sections were cut, including the whole thickness of the optic nerve head. In these sections the cornea, anterior chamber, iris, lens, ciliary body, and choroid are all normal in situation and appearance. The retina is moderately detached (artefact), but, apart from very slight cystic degeneration near the ora serrata, appears of normal structure. The nerve head is somewhat swollen and the thickness of the retina at the edge of the optic disc is about 0.75 mm. in section through the middle of the disc. There is no extension of neoplasm into the retina or through the sclerotic into the eyeball.

Examination of the serial sections under a 2-inch objective, shows the whole mass attached to the back of the eyeball to be thicker in transverse diameter on the temporal than on the nasal side of the optic nerve (see Fig. 4). On the temporal side, the mass is intimately adherent to the sclera for about 1/2 of its thickness on this side, and only for about 1/3 on the nasal side. The greatest thickness on the temporal side (in the sections examined) is 15 mm., and the greatest on the nasal side is 10 mm., whereas for a considerable part of the latter it is only 5 mm. thick. Study of the van Gieson stained sections gives evidence strongly suggestive that on the narrower (nasal) side of the nerve the dural sheath remains to a considerable extent intact, with a thin layer—about 0.5 mm. in thickness—of new growth between dural and pial sheaths. Here and there, the layer of fibrous tissue, which presumably represents the dural sheath, is perforated by growth cells which connect the thin layer beneath it with the mass covering it. On the temporal side of the nerve, lying on the pial sheath, there is a layer of growth from 2 to 3 mm. thick, along the greater part of the nerve, which is comparatively free from red-stained collagen fibrous tissue, and which is bounded peripherally by a much broken line of fibrous tissue, probably from the deepest layers of the dural sheath. Anteriorly, where the mass is attached to the sclera, strands of red-stained collagen fibrous tissue from the posterior layers of the sclera pass backwards subdividing into thinner strands to become lost in the mass. Posteriorly, the mass ceases abruptly at the line of section at which the layer—5 mm. thick—was cut off for fixation in Müller's fluid. Peripherally, the boundaries of the mass show in section an irregularly sinuous outline. Nowhere is there evidence of growth extension through the pial sheath into the nerve itself.

The mass, in sections stained by glychaemalum, is of a general purple colour; in sections stained by Weigert's iron haematoxylin and van Gieson's stain, it is of a grey or yellowish-grey colour, with many strands of bright red-stained fibrous tissue by which it is subdivided. This fibrous tissue stroma carries a moderate supply of blood-vessels and is continuous with strands of similar

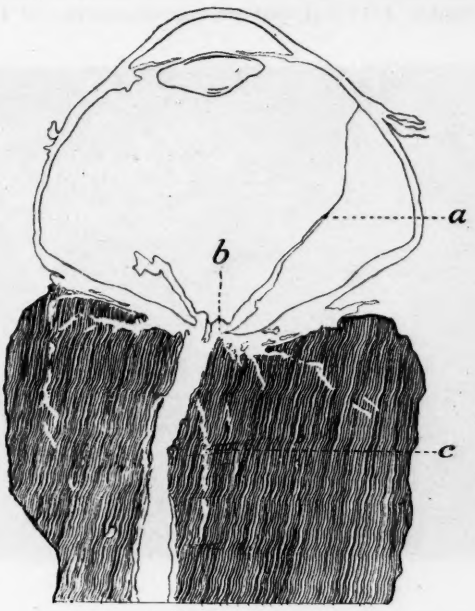


FIG. 4.

Drawing of section, showing the eyeball with the growth attached to it posteriorly: (*a*) Detached retina; (*b*) papilloedema; (*c*) incomplete fibrous partition in the growth, probably part of dural sheath, within which the growth has expanded the subdural space and further extended through splitting of the dural sheath into multiple lamellae.

tissue from the sclera and from the dural sheath of the optic nerve. There is a sufficiency of fibrous tissue to be seen in the sections to warrant the opinion that there is more fibrous tissue than could have arisen merely by permeation of growth into the dural sheath and sclera, and expansion of these tissues. In other words, there has been some proliferation of fibrous tissue to form supporting stroma and to carry blood-vessels to the neoplasm.

The paraffin sections of the posterior part of the mass (Müller fixed) show in part a whorl-like arrangement of cells and in part the formation of small spaces so typical of endotheliomata (Kettle

and Ross[1]; see Figs. 5 and 6). The smallest of the spaces appear to lie within the cytoplasm of individual cells close up against the nucleus in many cases. This vacuole formation is, to a less extent, to be seen in the thinnest parts of the celloidin sections also; but in these it gives more the appearance of a delicate sponge-work structure, as of numerous minute vacuoles lying adjacent to one another in different layers in the thickness of the section, when examined under 1/12 oil immersion objective. This vacuole

FIG. 5.

Microphotograph ×160 diam., shows portion of the growth near its surface. In the centre of the picture is a well-defined whorl-like arrangement of cells, with several others less well-marked. Among the cells are numerous spaces of various sizes, some between groups of cells, some within individual cells.

formation is studied only in the surface portions at the margins of the sections, where the action of the fixing fluids should have had an early effect and avoided the development of shrinkage.

The specimen above described bears a considerable macroscopic resemblance to two specimens in the Moorfields Hospital Museum. One is Mr. Goulden's case (Path. No. 1061 of April 22, 1910, Museum No. IV, G.2), examined and described by Mr. A. C. Hudson as a typical endothelioma. Sections of the above, kindly lent by Mr. Hudson and compared with the writer's case, show an identical type of cellular growth. The other is Sir J. H. Parsons' case[3] (Moorfields Hospital Museum, No. IV, G.3), which

was grouped by Hudson as one of fibromatosis, in his exhaustive investigation into and analysis of cases of optic nerve tumour.[4] For comparison, two microphotographs of parts of the fibromatosis specimen are reproduced, for the use of sections of which the writer is indebted to Sir J. H. Parsons. In one, under low power magnification, the posterior part of the eyeball and the anterior part of the growth are shown in section. The mass is seen to consist of a fibrous structure enclosing darkly stained islands of

FIG. 6.

Microphotograph ×400, shows the central portion of Fig. 3, and greater detail of the whorl-like collection of cells. Note that some of the spaces are definitely within the cell-protoplasm and in close contact with nuclei. (Photographs by Mr. F. Welch.)

cells. The second photograph shows, under high magnification, one such island of cells, which is largely formed of small round cells and is surrounded by concentrically arranged layers of fibrous tissue (collagen, stained a brilliant red by van Gieson's fuchsin stain). Some of these nodules are arranged with small round cells in the periphery, a few plasma cells, and epithelioid cells in the centre.

As stated above, there is considerable macroscopic resemblance between these two types of growth which do not arise in the nerve fibre part of the optic nerve.

Microscopically, there are well-marked differences. These are tabulated as follows:

(1) The fibromatosis case (*a*) is essentially a fibrous tissue mass. The tissue is intimately blended with the superficial layers of the sclera and with obliteration of Tenon's capsule. It blends in exactly the same manner with the surface only of the dural sheath. In a similar manner, it infiltrates the sheath of the

FIG. 7.

Microphotograph showing posterior part of eye in section, and anterior part of tumour (fibromatosis; case of Sir J. H. Parsons). The mass is composed mainly of cellular fibrous tissue and encloses islands of cell-infiltration which appear very dark in the photograph.

orbital muscles and in parts apparently destroys the muscle fibres, with infiltration of orbital fat.

(*b*) There are nodules or islands of cell-infiltration among the cellular fibrous tissue. These are mainly arranged with small round cells in the periphery, and a few plasma cells and epithelioid cells in the centre.

(*c*) There is endothelial proliferation in some of the small vessels, and, in parts, marked perivascular infiltration, which indicates inflammation.

(2) (*a*) The above described tumour (endothelioma) is essentially a cellular growth, with distinct separation between a large part

of the growth and the eyeball. There is no scleral involvement, but the growth is present in the subdural space and splits up the dural sheath.

(*b*) There are no nodules of cell-infiltration and only a minimum amount of new fibrous tissue.

(*c*) There is no visible vascular abnormality.

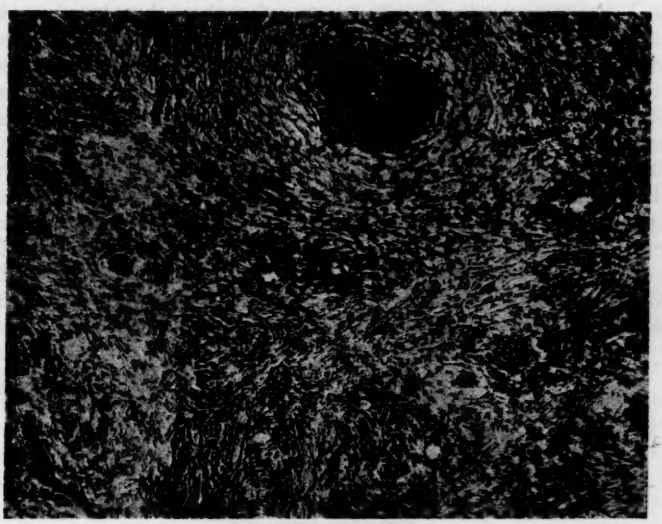


FIG. 8.

Microphotograph (magn. ×70), shows a small area of the same section (on opposite side of optic nerve). There is a darkly stained group of cells which are mostly small round cells, surrounded by concentric layers of fibrous tissue. The rest of the photograph shows cellular fibrous tissue with diffuse cell-infiltration. Some of the larger nodules contained plasma cells and epithelioid cells.

The means of differentiation on clinical grounds between Hudson's group of cases of endothelioma of the optic nerve and of gliomatosis and fibromatosis are tabulated in a previous paper by the writer.[2] The most important distinguishing features are that in the endothelioma group, the age of incidence is such that more than 50 per cent. start after the age of thirty years, whereas in the other group, more than 75 per cent. start in the first decade of life; and in the former group, there is a slight excess of cases in which exophthalmos precedes visual defect, whereas in the latter group, the primary defect is visual, in the majority; and that there is usually more limitation of movement in the eyeball in endothelioma than in gliomatosis or fibromatosis.

Conclusion

The growth described is a typical endothelioma. There is some evidence suggestive of the presence of a thin layer of growth which lies between the dural and pial sheaths on the nasal side of the nerve and that this layer of growth, wrapped around the nerve superficial to its pial sheath, much thicker on the temporal side, has on that side grown more rapidly and spread more freely into and through the dural sheath. On the other hand, it may quite well be stated that the growth arose as an extra-dural endothelioma, or from lymph channels in the dural sheath, and that it extended inwards into the subdural space. The neoplasm has extended to such dimensions that a decision as to this is impossible. However, as shown in a previous paper[2], an endothelioma arising in the endothelium of the subdural space, either superficial or deep to the arachnoid sheath, may at an early stage spread into and through, and largely destroy the arrangement of the dural sheath. Further, the subdural space is a recognized source of endothelioma of the optic nerve. It is probable, therefore, that the growth in this case originated from the endothelium of the subdural space.

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3. **Parsons, J. H.**—*Trans. Ophthal. Soc., U.K.*, Vol. XXIII, p. 116, 1903.
4. **Hudson, A. C.**—*Roy. Lond. Ophthal. Hosp. Reps.*, Vol. XVIII, p. 317, 1912.

GLAUCOMA SECONDARY TO CHOROIDAL SARCOMA. THE TREATMENT OF PAINFUL BLIND GLAUCOMATOUS EYES

BY

HUMPHREY NEAME AND WAJID ALI KHAN, M.B., B.CH.

THE occurrence of several cases of sarcoma of the choroid in eyes that were excised on account of pain and loss of vision with glaucoma, at Moorfields Hospital, led to the investigation of the incidence of new growth of the choroid in glaucomatous eyes that were excised during a period of eleven years from 1903 to 1911 and 1922 to 1924. Acknowledgments are due to the following surgeons for their kind permission to report their cases:—Mr. W. Lang; Mr. Flemming; Mr. Lawford; Mr. Spicer; Mr. Collins; Mr. Worth; Mr. Fisher; Mr. B. Lang; Mr. Whiting; and to Mr. Greeves for facilities given for the examination of sections

of five of the cases, from the pathological collection of the late Mr. George Coats. Cases of Mr. Morton and Mr. Hancock are also included.

During the period mentioned, there were 402 excisions performed for glaucoma. Of these cases 40 (10 per cent. approx.) were found, pathologically, to contain sarcoma of the choroid. In 21 of these cases, the growth was diagnosed on clinical grounds before excision. In three cases, a growth was suspected, but in the remaining 16, clinical notes of the cases fail to reveal any suspicion that a new growth was present. Out of these 16 cases, the operation of iridectomy was performed in three, and posterior sclerotomy followed by iridectomy in one. These four eyes, upon which operation had been performed, were subsequently excised, three on account of failure of the wound to heal and gaping thereof, and the fourth after a return to Hospital with detachment of the retina. The remaining 12 of these 16 eyes were excised on account of absolute glaucoma.

The descriptions which follow consist of abstracts from the clinical notes in the Moorfields Hospital records and of abstracts from the pathological reports of the Curator. The pathological statements have been verified during the composition of this paper by microscopic examination of sections in every case. The numbers are those of the pathological records in the Royal London Ophthalmic Hospital. The abstracts have been made as brief as possible, allowing for the inclusion of evidence as to glaucoma and evidence as to new growth of the choroid and its type. The term "spindle-celled sarcoma" is used to denote growths which have a markedly elongated spindle-shaped nucleus, and also those with an oval or oat-shaped nucleus.

No. 6750 (Fig. 1). J.W., aged 49 years, admitted with intense pain in left eye.

Examination showed: much injection of conjunctiva; ring keratitis and general haziness of cornea; no anterior chamber; anterior synechiae of margin of pupil; lens displaced forwards and opaque; no perception of light; tension plus 3; no view of fundus could be obtained; (Feb. 25, 1904) left iridectomy was performed; (Nov. 26, 1904) wound bulging, much injection; no anterior chamber; pain present; (Nov. 27) wound flattened; no anterior chamber; (Nov. 29) left excision.

Sagittal section left globe shows anterior chamber absent; lens and iris pressed against cornea, angle of chamber closed; retina detached. Choroid contains a large melanotic round-celled angiosarcoma; subchoroidal haemorrhages.

(No section of this specimen remains which shows the full extent of the growth and its base. The only section obtainable was that illustrated in which the summit only appears.)

No. 6785 (Fig. 2), C.W., age not noted; left eye injured with a whip 18 years ago. This eye was operated on three times, and inflamed two years ago. Painful for the last two weeks.

Examination showed: left eye very tender; cornea bulging, and vascular scars; anterior chamber deep; coloboma upwards; aphakia; no perception of light; tension plus 1; no view of the fundus obtained; right eye normal; (April 26, 1904) left eye excised.

Vertical section left globe shows: irregular anterior chamber; angles blocked; iris adherent widely at the periphery on both sides; lens shows peripheral remains after extraction; capsule is folded; retina detached and degenerated; there is a choroidal melano-sarcomatous growth, the cells of which are large oval, or spindle shaped.

No. 6976 (Fig. 3), F.F., aged 68 years, a history of defective vision in the right eye for six months, with halos. Three weeks before admission severe pain and vomiting. Eye painful since.

Examination of right eye showed: conjunctival and ciliary congestion; cornea hazy; shallow anterior chamber; pupil dilated, fixed, irregular; iris atrophic; vision, no perception of light; tension plus 3; no view of fundus could be obtained; left eye normal; (Feb. 21, 1905) right eye was excised.

Horizontal section of the globe shows: blocked corneo-iridic angles on both sides. Haemorrhage in anterior chamber. Retina is totally detached. About one disc diameter to temporal side of papilla is a choroidal growth with a broad base and a round head. There is no perforation through the sclera. The tumour is a leuko-sarcoma containing oval cells.

No. 7025 (Fig. 4), H.W., aged 66 years, history of rapidly failing sight in the left eye. For the last three weeks she could scarcely see at all.

On examination: there was intense ciliary and conjunctival congestion with conjunctival chemosis; a large shallow and infiltrated ulcer at the lower part of the cornea; lens opaque; vision, no perception of light; tension plus 2; no view of the fundus could be obtained; right eye normal; (May 19, 1905) left eye was excised.

Sagittal section of left globe shows a large hypopyon in anterior chamber over back of area occupied by ulcer. Anterior chamber fairly deep. Angles blocked on both sides. Retina detached. In the posterior part of the eye covering papilla is a large spindle-celled sarcoma, deeply pigmented.

No. 7027 (Fig. 5), E.R., aged 57 years, right vision failed very suddenly without pain in December, 1904. Eye became inflamed and painful one month ago.

FIG. 1 (6750)

FIG. 2 (6785)

FIG. 3 (6976)

FIG. 4 (7025)

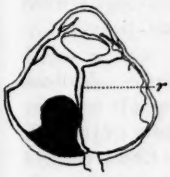

FIG. 5 (7027)

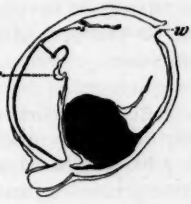

FIG. 6 (7041A)

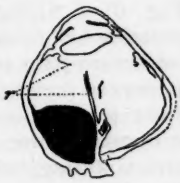

FIG. 7 (7312)

FIG. 8 (7313)

FIG 9 (7368)

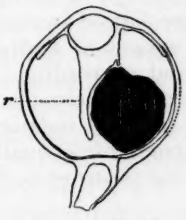

FIG. 10 (7862)

FIG. 11 (7906)

FIG. 12 (7986)

FIG 13. (8238)

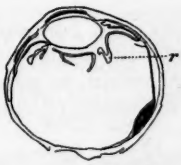

FIG. 14 (403)

FIG. 15 (416)

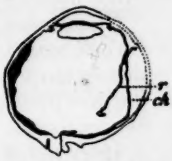

FIG. 16 (656)

NOTE re ILLUSTRATIONS.

The drawings are made with the help of a projection lantern. The shaded portion represents the size and position of the choroidal sarcoma. The variation in shape is due to distortion of the specimen during preparation of sections. Of No. 6785 (see Fig. 2), no section with more than a part of the growth in the section was obtainable. The *r* signifies retina, the letter *w* wound of operation.

Examination showed: right ciliary and conjunctival injection; cornea very hazy and oedematous; remains of old keratic precipitates; medium anterior chamber; pupil dilated, oval and inactive; lens opaque; no perception of light; no view of fundus obtained; tension plus 3; left normal; (May 10, 1905) right eye excised.

Horizontal section right globe shows: corneo-iridic angles occluded by adhesion of iris to back part of cornea as far as the ending of Descemet's membrane. Retina detached from papilla to ora serrata. On the temporal side of disc is a melanotic new growth with an expanded base, a constricted neck, and a round head. It is a spindle-celled deeply pigmented sarcoma. There is no evidence of extra-ocular extension or involvement of nerve.

No. 7041a (Fig. 6), S.S., aged 60 years, had misty sight with halos for six months before admission. Four days previously sudden attack of severe pain in right eye.

Examination showed: right congested; cornea hazy; shallow anterior chamber; pupil dilated, irregular and fixed; tension plus 2; left eye normal; (June 2, 1905) right iridectomy; (June 3, 1905) severe pain, vomiting, tension plus 3; (June 9, 1905) wound bulging, tension plus 1 or 2; painful and injected, no keratic precipitates; right eye excised.

Report on microscopic section: edge of corneal wound infiltrated; no trace of healing; iris prolapsed in the wound; angles are slightly blocked, not beyond spaces of Fontana. There is a tumour situated above the disc and measuring 7.5 mm. at base and 11 mm. in height. It is covered by remains of choroid and greatly degenerated retina which contains tumour cells. Tumour is a deeply pigmented sarcoma containing small irregular cells tending to be spindle-shaped. Nerve is atrophic. Retina is totally detached.

No. 7312 (Fig. 7), R.S., aged 39 years, history of pain and trouble in left eye on and off for twelve months. Quite blind for three months (August 23, 1906).

Examination showed: left ciliary and conjunctival injection; cornea steamy all over and covered with blood-vessels; no keratic precipitates; pupil dilated, inactive; vision, no perception of light; tension plus 2; no view of fundus obtained; (August 27, 1906) left eye excised.

Horizontal section shows: occluded angles; new formed tissue on anterior surface of iris; umbrella-shaped retinal detachment. On the nasal side of the nerve is a melanotic sarcoma 14 mm. at base, 8.5 mm. in height. It reaches from equator to nerve and invades the surface of latter. Tumour is a large spindle-celled sarcoma with comparatively scanty pigment.

No. 7313 (Fig. 8), M.H., aged 53 years, left glaucoma for three months.

Examination showed: (August 18, 1906) ciliary and conjunctival injection; cornea hazy, enlarged veins below; many fine pigmented keratic precipitates; pupil dilated, inactive, and discoloured; vision, no perception of light; tension plus 2; dull fundus reflex, no details seen; (August 20, 1906) left iridectomy; (August 23, 1906) very shallow anterior chamber; wound bulging; (August 27, 1906) fair anterior chamber; tension lower; (August 30, 1906) leakage; very shallow anterior chamber; (August 31, 1906) tension normal; injection, photophobia, and lacrymation; anterior chamber leaking; pigmented keratic precipitates; tension below normal; no view of fundus; (Sept. 3, 1906) left excision. [The notes add "? new growth," presumably on account of the visible mass involving the optic nerve (see Fig. 8).]

Sagittal section left globe shows: iridectomy wound above. Lens *in situ*. Angles adherent to beyond termination of Descemet's membrane. Umbrella-shaped detachment of retina. Over a large part of the posterior pole of the eye is an extensive sarcoma of flat type. There is a large extraocular extension which is connected with the intraocular growth through the lamina cribrosa and optic nerve. The cells are spindle-shaped, without any excess of pigment cells in the choroid, and none in the growth.

No. 7368 (Fig. 9), E.F., age not noted, left discovered to be blind twelve years ago. More than 20 attacks of pain and redness since. Right failing somewhat in past months.

Examination showed: left intense injection, photophobia, pain; cornea hazy and invaded by deep vessels; some keratic precipitates; fair anterior chamber; pupil semi-dilated and fixed; vision, no perception of light; tension plus 3; no view of fundus obtained; right normal; (Oct. 31, 1906) left eye excised.

Horizontal section of left globe shows: angles occluded. Lens *in situ*. Retina detached from nerve to ora serrata. On the nasal side there is an extensive tumour which commences a short distance in front of ora serrata and extends right on to the nerve entrance. Nerve is invaded by a mass with its apex at the cut end. Tumour is a spindle-celled melanotic sarcoma.

No. 7862 (Fig. 10), V.B., aged 64 years, had acute inflammation in the left eye one week ago.

Examination showed: right eye quiet; left intense oedema of the upper lid with chemosis of conjunctiva; circular marginal ulcer; no anterior chamber; vision, no perception of light; tension plus; no view of fundus obtained; (April 4, 1909) left excised.

Horizontal section of left globe shows: anterior chamber contains haemorrhage. Lens forwards. Angles occluded. Retina detached. On the temporal side of disc a melanotic tumour of choroid projects into the subretinal space. There are areas of

necrosis and haemorrhage in the growth. No evidence of extra-ocular extension. Tumour is a melanotic sarcoma containing oval and spindle cells, and is deeply pigmented.

No. 7906 (Fig. 11), S.A., aged 66 years, right glaucoma and iritis.

Examination showed: (May 28, 1909) steamy cornea with posterior synechiae; tension plus 3; (June 1, 1909) right, intense injection; absolute glaucoma with steamy cornea; iris vascular; lens opaque; broad posterior synechiae; vision, no perception of light; tension plus 2; left normal; (June 9, 1909) right eye excised.

Horizontal section right globe shows: occluded angles. Retina is detached. In the posterior part of the globe is a large melanotic sarcoma, it lies above and over the nerve entrance and is more on the temporal than the nasal side. The tumour is a spindle-celled sarcoma with very little pigment.

No. 7986 (Fig. 12), A.S., aged 55 years, sudden loss of sight in left eye six months ago. Eye previously quite good; pain for last 14 days.

Examination showed: left intense injection; cornea bright; anterior chamber very shallow; pupil slightly dilated and fixed; iris very vascular; vision, no preception of light; no fundus reflex; tension plus 2 or 3; (Nov. 13, 1909) left eye excised; new growth projecting from sclera behind; (Dec. 1, 1909) left exenteration of orbit.

Horizontal section shows: angles occluded nearly as far as edge of membrane of Descemet. Atrophy of iris. Umbrella-shaped detachment of retina. On nasal side of disc stretching backwards from equator is a melanotic tumour of the choroid. Tumour cells are of various types, but mainly large polygonal. Tumour is insinuating itself between the lamellae of sclera in a zig-zag manner.

No. 8238 (Fig. 13), A.B., aged 47 years, left eye inflamed and painful for 10 days.

Examination showed: left eye much injected; cornea hazy; pupil semi-dilated and oval; no fundus reflex; vision, perception of light; tension plus 3; right eye normal; treated with hot bathing and oily eserin every half-hour; tension became slightly less and pupil smaller; (Nov. 15, 1910) left posterior sclerotomy and left iridectomy; (Dec. 1, 1910) left eye slightly injected; cornea bright; anterior chamber shallow; no fundus reflex; tension normal; vision, perception of light; (Dec. 5, 1910) discharged; eye white, tension normal; (Jan. 5, 1911) left moderately injected, cornea oedematous; iris discoloured; retina totally detached; no perception of light; tension plus 2; (Jan. 6, 1911) left eye excised.

Horizontal section shows: angle occluded on one side by apposition of iris to cornea. Large deeply pigmented growth

springs from posterior and inner part of choroid. Retina completely detached. Tumour is composed of polyhedral and round cells with varying amount of pigment.

No. 403 (Fig. 14), P.E., aged 69 years, history of pain in right eye for three weeks. Had never seen well with it. No history of injury.

Examination showed: marked ciliary and conjunctival congestion; cornea oedematous; anterior chamber shallow; lens opaque; tension plus 3; vision reduced to bare perception of light; no view of the fundus could be obtained; left eye normal; (Oct. 13, 1921) right eye excised.

Macroscopic description: horizontal section above the nerve. Anterior chamber reduced to a mere slit. Iris in contact with posterior surface of the cornea throughout the section. Retina totally detached and in contact with the lens. On the nasal side of the disc is a nodular mass projecting from the choroid. The mass is a deeply pigmented spindle-celled sarcoma of the choroid. (Histological microscopic section only included the marginal portion of the growth.)

No. 446 (Fig. 15), H.R., aged 38 years, failing sight in the right eye for three years. Completely blind for six months. Much pain for the last three months.

Examination showed: ciliary injection; hazy cornea; shallow anterior chamber; pupil semi-dilated and inactive; vision reduced to perception of light; tension plus 2; no view of the fundus could be obtained; left eye normal; (Nov. 24, 1921) right eye excised.

Horizontal section through the upper edge of the disc. Anterior chamber shallow. Complete detachment of the retina. A dome-shaped mass arises from the choroid and surrounds the disc. The growth is a spindle-celled melano-sarcoma.

No. 656 (Fig. 16), R.M., aged 67 years, severe and persistent pain in the left eye three days previous to admission. Twelve weeks previously had first similar attack. Several attacks since.

Examination showed: conjunctival congestion; cornea hazy and bullous; pupil inactive and semi-dilated; vision, no perception of light; tension plus 3; no view of the fundus could be obtained; right eye normal; (Sept. 13, 1922) left eye excised

Horizontal section above the optic nerve shows angles of the anterior chamber blocked at the extreme periphery. Iris and lens normal. Retina detached on the nasal side over the swelling. Choroidal tumour extending from 2 mm. posterior to the root of the iris back to the disc edge. Glaucomatous type of cupping. Swelling is a flat spindle-celled melano-sarcoma of choroid.

The result of this investigation has been to demonstrate that, without doubt, the occurrence of sarcoma of the choroid in cases

of blind painful glaucomatous eyes is something more than a rarity. On the contrary, the fact that among 402 cases in which glaucomatous eyes were excised, 16 (4 per cent. approx.) proved to contain sarcoma of the choroid, is a very definite indication of the considerable danger that exists in a patient in whom such an eye is treated by any means other than excision. Attention is drawn to the fact that this proportion (4 per cent.) concerns cases in which there was not the least suspicion of new growth, as exemplified by the fact that in four of these, operations were performed for the treatment of the glaucoma. Incidentally, the high percentage of cases of sarcoma in this total of glaucomatous eyes (10 per cent.) gives food for thought, in connection with the cause of glaucoma.

Summary and Conclusions

(1) Of 402 eyes excised on account of glaucoma, approximately 10 per cent. were found on pathological examination to contain a choroidal sarcoma; 4 per cent. were blind glaucomatous eyes in which there appears, from the clinical notes, to have been no suspicion of the existence of a new growth.

(2) Of these 16 cases of sarcoma of the choroid, 13 were spindle-celled, 3 were round or polygonal-celled, 12 were pigmented and 4 possessed but scanty pigment or were unpigmented.

(3) The average age of 14 of the 16 cases at the time of excision was 57 years, the maximum 69 and the minimum 39 years. No assistance is to be obtained, in the matter of the diagnosis, from a consideration of the age of the patient. In this series, the average age was well above the average age of appearance of sarcoma of the choroid (from 44.2 to 48.7 years[1]) and near the middle of the age period of onset of congestive glaucoma (from 50 to 70[2]).

(4) *The treatment of cases of blind painful glaucomatous eyes should be enucleation*, especially if the glaucoma is unilateral, excepting in a few cases in which the media of the eye are sufficiently transparent to enable examination of the fundus oculi to be made. In such cases, if there be an obvious anterior detachment of the retina and if the presence of a new growth is not suspected or is doubtful, one of two procedures may be adopted as a preliminary to further surgical treatment:

(*a*) Scleral puncture into the space external to the detachment and ophthalmoscopic examination to ascertain whether the detachment (or retinal cyst) has diminished in size.

(*b*) Dissection of a scleral flap, with its apex placed anteriorly, made over the site of the detachment. Very cautious dissection and elevation of the flap is essential in order to avoid damage to a choroidal sarcoma, if one be present, and dissemination of growth cells.

After-images of Normal

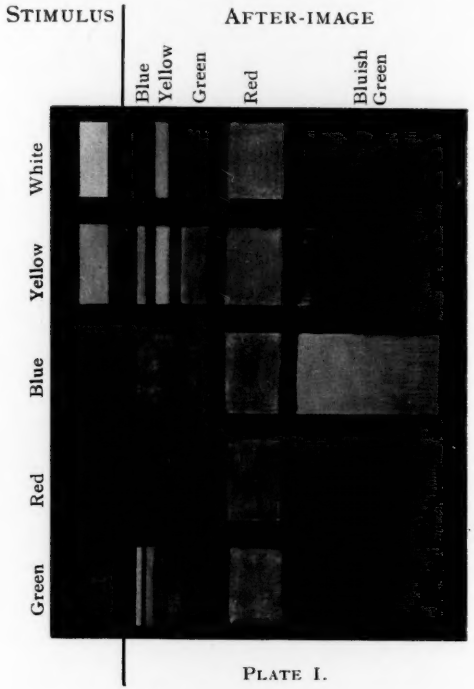

Plate I.

After-images of Dichromat and Anomalous Trichromat

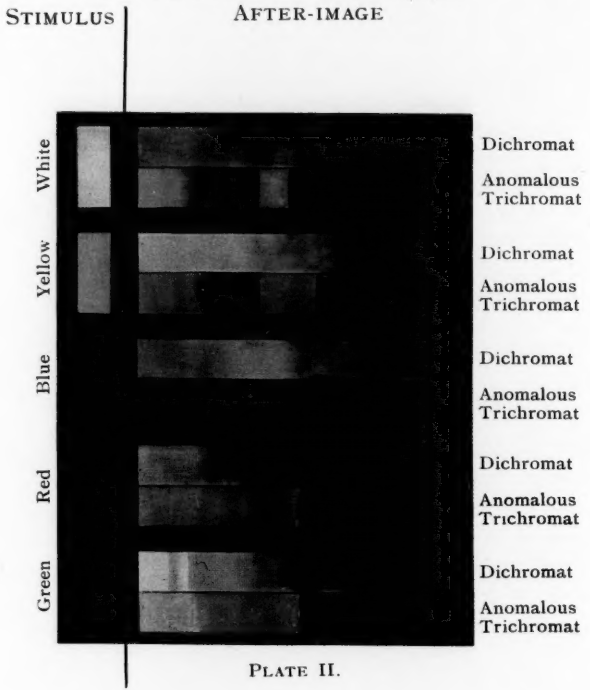

Plate II.

Of these two methods, the latter is likely to be the less dangerous. In the event of the acquisition, by this means, of evidence of the presence of a growth, the eyeball should be enucleated immediately. If no such evidence be obtained, the wound may be closed and further operative treatment adopted for the glaucoma, if considered advisable, at a later date.

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THE COLOURS OF AFTER-IMAGES, FOLLOWING STRONG LIGHT-STIMULI

BY

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I. Introduction

THIS communication deals with the colours of after-images, following strong light-stimuli, as observed in absolute darkness. We will call these "original" after-images, whilst those modified by fresh light-stimuli will be named "induced" after-images. The observations and theories of former authors (Fechner[1], Plateau, Brücke[2], Helmholtz[3], Séguin, Burch[4] and McDougall[5]) will not be discussed here as it is my intention to bring forth in this first communication mere facts, leaving theories for later.

For control of my results the conditions of examination should be identical. The observers must be familiar with physiological work, and their colour sense should be carefully examined. Observations must be carried out uniocularly and in absolute darkness. All influences that could distract the observer's attention should be eliminated. Some exercise is required as the periodical fading of the after-images is disturbing to the beginner. This phenomenon will disappear nearly entirely as a result of sufficient practice.

No pigment-lights were used. In examination with strong light-sources like direct sunlight and electric arc lamp the excess of ultra-violet rays should be absorbed by the use of colourless glass of sufficient thickness. Much care has to be taken that all after-images of previous light-stimuli have disappeared before starting a new experiment. The observations were registered by speaking in a dictaphone, and a metronome marked the time in

the same instrument. The duration of the stimulus was regulated by a photographic shutter.

In this way the writer found that the after-images of so-called "white" light of high intensity show a very typical and constant series of colours that is the same for all observers in possession of the same colour sense.

The after-images of spectral radiations of high intensity show other series that are also typical and constant for those radiations and show typical deviations in case of defective colour sense.

A certain intensity of stimulation is wanted for development of the whole series. If this "optimal" degree is once reached, further increase of intensity or duration of stimulation can only influence the duration and brightness of the different colour phases. In case of stimulation of lower intensity or very short duration the series is shortened so that the colours that otherwise were first observed will not now develop. The periodical fading of the after-image and the so-called "halo" will not be considered.

II. The after-image of so-called white light

Let us begin by describing what is observed after staring at the sun for a few seconds. Immediately after the termination of this stimulus we often have a feeling of confusion, called by McDougall "dazzling period." Then we suddenly observe a disc of clear light blue colour. It is not the blue of the Italian sky, but the less saturated luminous blue of a Dutch sky in bright sunlight. After a short time this blue is replaced by an equally clear golden yellow, generally of short duration, and this passes *via* a yellowish green into a pure spectral green of rather full saturation. This in its turn is, after some time, replaced by an unsaturated crimson, approaching purple rather than spectral red. This red is so constant and characteristic that whenever observing it as a primary light perception I for long have been in the habit of calling it "after-image red." This phase again lasts longer than the preceding green phase; finally, it is replaced by a deep bluish-green.

Under favourable conditions we observe this bluish-green with a clearness which shows that it differs in no respect from the other colour phases. The fact, however, that in many cases the after-image has in this stage decreased so much in intensity, that the colour can hardly be identified and the surrounding "halo" seems brighter than the after-image itself, has induced former observers to indicate this phase as a "negative" one.

Here I wish to state as my opinion that the words positive and negative should not be used in the description of the original after-image as this would cause confusion with the entirely different

sense of the words in the description of secondary after-images. Moreover, they include a presumed theoretical explanation of the facts observed.

After an observation of several minutes the after-image will disappear altogether, but a very weak light-stimulus will show, that the part of the retina formerly struck by the sunlight has by no means returned to its primary state. There still exists a relative partial scotoma, and, moreover, new after-images of the sun can be formed. These are colourless if the secondary stimulus is weak. The latter phenomenon will not be further discussed here.

The case here described is an ideal one as it is supposed that the fixation of the sunlight was perfect. In most cases this fixation will be imperfect and in consequence the centre of the image will be much more strongly stimulated than the periphery.

As the after-images show more colour phases in proportion to the intensity of the light action the centre will generally show another colour than the periphery, and even three or more colours can appear in the same after-image so that the centre is surrounded by two or more rings of different colours. Imperfect fixation of the source of light may also account for the fact that the colour changes seem to proceed from the periphery to the centre.

If the after-image passes from one colour to another, which is not complementary, as for instance from yellow to green, this change mostly occurs *via* the mixed colour, in this case yellow-green. If, however, the change takes place from a colour to its complement, for instance from red to green, this does not occur *via* the mixed colour yellow, but the change is a sudden one recalling the way in which moisture fades from a hot surface (Fechner), or in other cases there is for one moment a mosaic work of both colours.

The colours themselves show alterations in their saturation, especially the carmine red is ofen unsaturated, although it may now and then reach a high degree of saturation so that one might agree with McDougall that perhaps there is no other method that enables us to obtain more saturated colour perceptions, but generally the author's red is not so saturated as McDougall's seems to be. Apart from the fluctuations of saturation the after-image as a whole diminishes in brightness in proportion to the time it lasts.

As said before, the colours succeed in invariable order. If the light stimulus is weaker, the series starts with yellow-green or green or even with red, and in this case only these colours will be observed that follow in the invariable order: blue, yellow, green, red, bluish-green. As a consequence the colour that is first observed also disappears first. The author never observed in the after-image pronounced spectral red, orange, and spectral violet.

III. On the after-images of strong spectral radiations

As a spectroscope allowing intense stimulation was not at the author's disposal, light-filters had to be used for the examination of the after-images of spectral radiations. The Wratten monochromatic filters (Wratten, Wainwright, Ltd., Kodak House, London) were used in combination with direct sunlight, electric arc and quartz mercury lamp.

Here follows the result of repeated spectroscopical examination of the filters:

No. in Catalogue	Colour in daylight	Wave length in $\mu\mu$	Colour in spectroscope, using sunlight
70A	Red	650-720	Red
74	Green	515-565 (trace 700-800)	Green, with very faint trace of red
76	Blue	430-475	Blue and violet
73	Olive-green	550-620 (trace 670-740)	Yellow, yellow-green, trace green and trace orange-red
G	Yellow	520-700	Red, orange, yellow, yellow-green up to 520$\mu\mu$

The spectrum of our quartz mercury lamp showed the following lines: Yellow 577$\mu\mu$, green 547$\mu\mu$, blue 436$\mu\mu$, violet 405$\mu\mu$. Combination of this lamp with filter 76 gives pure blue 436$\mu\mu$; combination of this lamp with filter G and filter 73 gives pure yellow 577$\mu\mu$.

Thus the filters 70A and 74 in combination with arc light or sunlight provided us with spectral red and spectral green of high intensity, and the use of the filter 76 and the combined filters G. and 73 with the quartz mercury lamp secured us a pure spectral blue and yellow. The duration of exposure varied from 1 to 20 seconds. We found here just as in the above-mentioned experiments with so-called "white" light, that the full series of after-image colours, characteristic for each spectral radiation, develops by using stimulations of moderate intensity and duration. Stronger stimulation can only influence brightness and duration of the after-image. The best results were obtained with exposure lasting from 5 to 10 seconds, using direct sunlight and the above-mentioned filters. Controlling observations were made by excluding ultra-violet rays by adding a sheet of heavy flint glass (Schott, Jena). This had no influence on the results obtained, but is advisable as a protection of the fovea. Using the quartz mercury lamp care should be taken to exclude, with the help of screens, the light

radiated by the glowing quartz. The principal results of our observations follow here:

1. Using sunlight:

Spectral red gives the following series of after-image colours.
Spectral green.
Carmine red.
Deep bluish-green.

Spectral green gives:
Yellow.
Yellow-green.
Green.
Bluish-green (sometimes with blue mosaic).
Carmine red.

Spectral blue plus violet gives:
Spectral blue.
Violet purple.

2. Using arc lamp:

Spectral red gives exactly the same colours as by using sunlight.

Spectral green gives:
Exclusively green.
(Here yellow as well as red observed in using direct sunlight failed.)

Spectral blue plus violet gives exactly the same colours as by using sunlight.

3. Using quartz mercury lamp:

Spectral yellow gives:
Bluish-white (fails often).
Yellow or yellow-green, quickly passing to green.
Carmine red.
Deep bluish-green.

Spectral blue gives:
Light blue.
Unsaturated carmine red.
Dirty yellow-green in which later on the green slightly predominates.

With the help of a collection of pastel colours we have tried to fix the most characteristic colour phases of the after-image. (Plate I.) As the carmine red is the only colour we meet with in *all* after-images we arranged the colours in such a way that this red is found in the same vertical row.

Primary light	After-image				
White ...	Blue	Yellow	Green	Carmine red	Bluish-green
Yellow ...	Bluish-white	Yellow	Green	Carmine red	Bluish-green
Blue ...	Blue	—	—	Carmine red	Yellow-green
			Bluish-green		
Green ...	—	Yellow	Green	Carmine red	—
Red ...	—	—	Green	Carmine red	Bluish-green

In this scheme we have limited ourselves to the reproduction of the most constant and characteristic colours. The change in saturation as well as the appearance of colour mixtures gives rise to richer variations than are reproduced here. The reproduction does not give in any way an exact representation of the course of the after-image process. The dark intervals which separate the colours are entirely arbitrary and should not be identified with the phases of darkness that often, and more or less systematically, interrupt the course of the process. Our registrations with help of the dictaphone prove that there is not the slightest connection between these periodical obscurations and the different colour phases. Also the duration of the different colour phases is not exactly reproduced. The author merely wanted to indicate that generally the first phases are the shortest and that generally they last the longer the later they occur in the series.

Nevertheless this scheme allows us to point out some remarkable facts. We have mentioned already that the characteristic carmine "after-image red" is the *only* colour that returns in all the experiments. Secondly, it strikes us that with few exceptions the succession of the colours is in all cases the same as it is for white light. Some phases may be omitted—the succession is the same. The only exception seems to be that in the after-image of green the green takes a bluish hue before changing into red whilst in the other observations a bluish-green followed this same red, but this fact cannot entirely suppress the suggestion that the after-image colours of the different spectral colours examined are parts of the whole cycle developed by white light. *It seems to be a general rule that spectral radiations cannot develop any after-image colour that is not to be found in the cycle of the so-called "white" light* (apart from differences in saturation and hue).

If we consider the different radiations more closely still, other remarkable facts will strike us. First the great analogy of the after-image colours of white and pure spectral yellow is astonishing. In some of my observations a first phase of unsaturated blue was noticed; in others I was inclined to call this phase colourless, whilst in a third series of observations this phase seemed to fail. In all further respects the identity of the after-image colours of yellow of wave length 577$\mu\mu$ with those of sunlight and arc light is complete. This seems to indicate a very high degree of identity between the biochemical processes caused in the retina by such different stimuli.

The spectral blue of wave length 436$\mu\mu$ causes nearly the same after-image colours as the blue combined with violet (430-475$\mu\mu$) and both differ widely from the after-images of white light, consisting nearly exclusively of a blue and a carmine-red phase. In contrast with the well-known facts, stated with induced after-images, the so-called complementary phase is missed in the original after-image of blue. The dirty yellowish-green I observed sometimes as a last faint phase of the series can hardly be considered as such.

The spectral green (515-565$\mu\mu$) in its turn gives, much like the spectral yellow, nearly all the after-image colours of white, but in a somewhat modified order. Only the blue phase is missed entirely.

The spectral red on the contrary gives only the last three phases of the after-images of white. It is the only colour examined, in whose after-image the so-called "complementary" colour predominates. We know that a certain mixture of thallium-green and lithium-red gives the impression of sodium-yellow. It is a striking fact that addition of the after-image colours of spectral red and green does not form the cycle of yellow. The blue phase is still missing, as well in the after-image of red as of green. Only by adding a third colour—blue or yellow—the whole cycle as observed in white or yellow light is obtained.

If we agree with Götz[6], who describes the after-images as "selbständige, auf selbständigen physiologischen Prozessen (Nachwirkungen der photochemische Folgen des Lichteindrückes) beruhende psychische Erscheinungen" then the study of "farbiges Abklingen" teaches us that the biochemical processes of the retina caused by pure spectral radiations are much more complicated than some theories of colour vision might suggest. If red, for instance, is the sole colour examined, it presents in its after-image chiefly "complementary" colours as Hering's theory would demand. For blue and yellow, however, a "complementary" phase in the after-image fails completely or practically so, whilst the appearance of yellow in the after-image of green remains unexplained by Hering's hypothesis. Both Helmholtz and Hering were well aware that the

study of the colours of the after-images was in contradiction with their theories.

Hering[7] wrote in 1878 "Von der Anwendung einer irgend starken Beleuchtung muss bei diesem wie bei allen folgenden Versuchen ganz besonders gewarnt werden, weil man dadurch nicht blos seine Augen angreift, sondern, was das eigentlich Wesentliche ist, ganz andere und sozusagen unreine Resultate bekommt."

Helmholtz[3] writes: "Die sehr zusammengesetzten Erscheinungen des farbigen Abklingens starker oder anhaltender Lichteindrücke vollständig auf ein einfaches Schema zurückzuführen, möchte freilich vor der Hand noch schwer sein und allerlei willkürliche Annahmen nothwendig machen."

With due respect to two giants of science like von Helmholtz and Hering the author ventures to give as his opinion that the study of the original after-images of strong light-stimuli might be of much use for the study of light perception and even that the induced after-images can only be understood after studying the original after-images.

This is a first attempt, and I am well aware that it is very incomplete. Though we succeeded in experimenting with spectral red, green, blue, and yellow of high purity and brightness we could not extend our observations to spectral orange, yellow-green, blue-green, and violet. The reactions caused by these radiations are, however, of special interest, and our next task should be to find out whether the after-images of orange are intermediate between those of red and yellow and whether those of yellow-green and blue-green are intermediate between the after-images of the separated colours.

If a spectrum of high luminosity were at our disposal it would be very interesting to seek the "curve" of after-image colours throughout the spectrum for radiations of "optimal" brightness. As "optimal" brightness I regard the lowest brightness that produces clearly the whole series of after-image colours which are characteristic for a distinct radiation. Further progress of our knowledge is to be expected from the study of the after-images in different parts of the retina. It is to be understood that the above observations refer only to central perception. In this communication we will also give some account of the after-images in cases of defective colour sense.

IV. On the colours of after-images, following strong light-stimuli as observed by Daltonists and anomalous trichromats

It seemed to me of both theoretical and practical importance to study the after-images of Daltonists and anomalous trichromats. For this purpose I had the assistance of two colleagues—ophthal-

mologists—Drs. M. and S., to whom I am greatly obliged as it is of much importance to experiment with good observers, therefore I will give their results *in extenso*. The colour sense of both was thoroughly examined not only with the pseudo-isochromatic figures of Stilling and the "Tafeln" of Nagel, but also with Nagel's anomaloscope and even the spectral curve of brightness was determined for one of them (Dr. M.). For comparison with later observers I will give the results of the examination with the anomaloscope for both of them.

Dichromats, or so-called Daltonists, perceive in their after-images, independent of the kind of inducing radiation, either no colour at all or they call it yellow or bluish, but they never seem to observe alternative changes of colour in the same after-image. They never spontaneously mention red or green; if asked for it they now and then call some phase reluctantly "reddish." Here follow the results obtained by Dr. M., who is a pronounced protanopic Daltonist, though he himself protests against the idea that he would not be able to perceive "red and green."

Examination with Nagel's Anomaloscope. If the left screw indicates pure green, then the right screw is turned to 57. If the left screw gives pure red, then the right is turned to 3. The Rayleigh-equation is adjusted almost in the same way as by normal observers. (Yellow 22 is red-green 51.)

AFTER-IMAGES.

White light (electric arc light) After-image: "White" or in other experiments "blue or bluish" (with yellow halo).

Spectral Red (Filter 70): Colour of After-image undefinable; of very short duration.

Spectral Red and Orange (Filter 71) After-image: A dull blue.

Spectral Blue and Violet (Filter 76) After-image: "White"; in other experiments faintly blue or faintly yellow.

Spectral Green (Filter 74) After-image very faintly yellow hue, later on pure white.

Spectral Yellow (Filter G and 73 with mercury lamp) After-image "bluish."

Analogous results were given by other Daltonists without exception.

The anamalous trichromats in contrast with the Daltonists perceive without any difficulty a much richer series of colours, as is illustrated by the results obtained by Dr. S., who is an extreme deuteranomal. Dr. S. himself did not admit that his sense of colour vision was defective though his family had often told him so. By examination with Nagel's Anomaloscope—

Experiment 1.—A pure red is presented; the yellow has to be changed into equality.

Right eye: One moment adjusted yellow 12, immediately afterwards rejected.

Left eye: Rejected "it must be about yellow 15."

Experiment 2.—Adjusted yellow 12.5; the red-green mixture must be changed until equality is reached.

Right eye: Equality red-green 68.

Left eye: Equality red-green 68.

Experiment 3.—Red-green adjusted to 49 (average of deuteranomals). Brightness of yellow must be changed into equality.

Right eye: Equality, yellow 20 to 18.

Left eye: Equality, yellow 17.

Experiment 4.—Red-green adjusted to 70 (average of protanomals). The yellow has to be changed into equality.

Right eye: Impossible to reach equality.

Left eye: Impossible to reach equality, seeks about 11.5.

Experiment 5.—Pure green is adjusted. Yellow has to be varied into equality.

Right eye: Green is equal to yellow 32.

Left eye: Green is equal to yellow 31.

From this and other examinations it is clear that Dr. S. is an extreme deuteranomal.

For Dr. S. we found the following after-image colours in repeated observations:

"White" light (Sun): Yellow-green, red, dark blue.

"White" light (Auer lamp): Yellow, green, red, blue-green, blue.

Spectral Yellow (577 $\mu\mu$): Yellow-green, green, "tile" red, blue.

Spectral Blue (436 $\mu\mu$): Blue (sky blue), green-yellow, orange-brown into rust red.

Spectral Green (515-565 $\mu\mu$): Yellow, pink (also called, unsaturated red and orange red), green, or blue-green or blue.

Spectral Red (650-720 $\mu\mu$): Yellow (also called orange), red, green (also called green-blue, and dark blue).

In all these observations the author could compare his own after-images directly with those of Dr. S. They did not differ in any essential respect from those described before.

Though the extreme deuteranomal described his after-image colours with much certainty it was clear from comparison of different observations that he had some difficulty in determining the hue of obviously identical phases. So in one series he called blue-green what in another was called blue or blue-green. In one series he called "orange-brown," what in another was called "rust red," and so on. I will not discuss here to what degree the differences between the normal and the anomalous trichromat are only apparent, because of the fact that his nomenclature is different,

but comparison of the results here obtained with those of the dichromat and the normal shows evidently that there is an enormous difference between the dichromat and the anomalous trichromat on the one hand and a close resemblance between the after-images of the anomalous trichromats and the normals on the other hand.

This resemblance is best illustrated by comparing Plates I and II. In Plate II, I recorded in colours the description of Dr. S., just as I myself understood his nomenclature and then for comparison added the after-image colours of the dichromat.

From this illustration we learn the following: First we see that deuteranomals just as normals perceive in the after-images of spectral radiations only such colours as are found in the after-image of the so-called "white" light, being his only fundamental colours, yellow, blue, red, and green. Then we must draw attention to the fact that just as in normal trichromats, the after-images of "white" and yellow are nearly identical. They only differ from those of normals by the absence of the first phase, the sky-blue. (There are some other differences of less importance as the use of the name "tile-red" in the carmine-red phase of the normal.)

The after-images of blue (Dr. S.) show also the remarkable fact that this is the only radiation examined where the first phase of the after-image is completely identical with the primary perception. For the after-images of red and green it is highly characteristic for Dr. S. that they are practically identical. This well coincides with the fact that they are "interchangeable" colours.

Up till now I am not able to foretell whether it will be possible to distinguish by the study of the after-image colours the different forms of anomalous trichromats, as it is essential to examine trained observers, who were not at my disposal. As far, however, as Daltonists and anomalous trichromats are concerned there is perhaps no method that enables us to distinguish those categories with such simple means. An incandescent lamp, an electric bulb, a little bit of sunshine allow the differentiation.

As far as I survey the literature on this subject only Guttman[8] has paid attention to the after-images of the colour blind. According to him the after-images of anomalous trichromats, if examined with spectral radiations, are in agreement with those of dichromats; if examined with pigment-colours on the contrary they would agree with normal trichromats. The intensity of the radiations used by Guttman is, however, much lower, and his results, therefore, are not directly comparable with those above described.

Once more the author wishes to state that this first communication does not exhaust in any way the subject, but he will be rewarded

if the results obtained awaken some interest in a method of investigation of the problem of light and colour perception that, in his opinion, has been too long neglected.

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ANNOTATION

Ophthalmic Folk-lore

In considering ophthalmic folk-lore we can divide the subject into matters pertaining to the evil-eye and ocular remedies. The first of these is pure superstition, a survival of the belief in witchcraft, which if not yet entirely eradicated from the more remote parts of the country, must, in these enlightened times, be very rare indeed. We do not propose to say any more about the evil-eye, but to confine ourselves to the primitive ophthalmic remedies of the countryside.

The popular superstition that rain water caught on Ascension Day is good for sore eyes can have, we think, no foundation in fact. Rain water caught on any other day in the year would be just as cleansing, and as an eye-wash could do but little harm. The various Holy wells, the waters of which are popularly supposed to be good for inflamed eyes, owe their success apart from the psychological effect, probably to the salts dissolved in the water and to the general cleansing effect of the water. It is difficult to see any scientific basis in the treatment of styes by rubbing them with a ring, whether the ring be made of gold or of iron from the nails of coffins; but for all that, it was a popular remedy among country folk. Probably there is more to be said for the practice of applying half a rotten apple to a stye; this would act like a bread poultice, and would probably be as septic and occasionally as efficacious as that old-fashioned remedy.

Flowers and plants, of course, had and still have a large part to play in the treatment of eye diseases. Eyebright, fennel, rue, and

mallows were all favourite remedies for all sorts of eye disease; and in our own day rose water is no infrequent ingredient of an eye lotion.

"But to nobler sights
Michael from Adam's eyes the film removed,
Which that false fruit that promised clearer sight
Had bred; then purged with euphrasy and rue
The visual nerve, for he had much to see."

In ancient times, he was probably the best physician who doubted most and did least, leaving the cure of the case to the *vis medicatrix naturae;* the same is probably true, within limits, of the early ophthalmic quacks, only it is hard to imagine a quack sitting still and doing nothing.

The unpleasant applications of fasting spittle and mother's urine to the eye are only mentioned to be condemned; the first we have seen the results of in a severe case of hypopyon keratitis and the second must undoubtedly have been responsible in the past for a certain amount of ophthalmia neonatorum.

ABSTRACTS

I.—PATHOLOGY AND HISTOLOGY

(1) **Speidel, C. C. (Charlottesville, Pa.)—The effect of thyroid administration on the eye of the frog tadpole.** *Jl. Amer. Med. Assoc.*, July 12, 1924.

(1) **Speidel** has been investigating the acceleration in the metamorphosis of tadpoles brought about by feeding them with thyroid. A definite exophthalmos occurs a few days after the first feeding, whereas in a normal tadpole the protrusion of the eye at the same age is only slight. The exophthalmos is due to an increase in the size of the eyeball (this increase occurring chiefly in the anterior part) and to general shrinkage of the adjacent tissues of the face. Histologically the growth is found to be due to proliferation of the cells of the basal layer of the retina in the region of the ora serrata—this proliferation is indicated by a very active mitosis—whereas in the untreated animal no mitosis is observable in this portion of the retina. It is stated as characteristic of the action of thyroid that it stimulates mainly the growth of undifferentiated or embryonic cells, thus explaining the selective effect of thyroid on the eye. Turning to exophthalmic goitre in man, Speidel, assuming that it is an indication of hyperthyroidism, suggests that the protrusion may be partly caused by

actual growth and multiplication of cells in the anterior part of the eyeball. Myopic change occurring in a sufficient number of cases with the onset of exophthalmos would help to establish this theory.

F. A. WILLIAMSON-NOBLE.

(2) **Hiroishi, H. (Japan).—On the development of cataract after removal of the parathyroids in rats. (Ueber die parathyreoprive Kataraktbildung bei Ratten.)** *Arch. f. Ophthal.*, Vol. CXIII, 1924.

(2) In this research **Hiroishi** endeavoured to determine whether the formation of cataract regularly, or indeed certainly, follows the removal of the parathyroids in rats, or is only an occasional phenomenon in the symptom-complex.

His observations were made on nine animals that survived operation. The lens opacities, which were best studied with the aid of the slit-lamp, were always bilateral, and their onset was from six to thirty-five days after the operation—being almost simultaneous in both eyes. The first changes were always visible in the axial area as fine radial striae that soon increased in number and in length towards the equator of the lens. These striae made fairly rapid progress in the first few days, after which they remained stationary and unchanged throughout the period of observation, so that the great mass of the lens remained clear: in no case did the lens become totally opaque.

This limited progress of these opacities is probably due to the fact that the factors producing them were present for only a limited time. The striae formed during that period remained, but no fresh ones developed later. The disappearance of these factors is attributable to the gradual resumption of function by the small accessory parathyroid clumps.

The author concludes by saying that tetania parathyroideopriva in rats runs a relatively mild and chronic course, the symptoms disappearing after a time or, as in the case of the lens, making no further progress. He emphasizes the fact that the development of cataract is the most constant symptom. It occurred in all the animals in which both parathyroids had been with certainty removed. In the cases where only one parathyroid had been excised, the formation of opacities was the exception. The onset of convulsions appears to hasten the development of cataract, but the latter may also occur without them. Changes in the teeth and hair may develop independently of those in the lens or may be absent altogether; no rule could be observed on this point: they seem, however, to be less constant symptoms than the cataract.

THOS. SNOWBALL.

(3) **Finoff, William C. (Denver, Colo.).—Changes found in eyes of rabbits following injection of living tubercle bacilli into the common carotid artery.** *Amer. Jl. of Ophthal.*, February, 1924, and May, 1924.

(3) **Finoff** injected clumps of living tubercle bacilli into the common carotid artery of 46 rabbits, and lesions developed in all the animals inoculated. Bovine bacilli proved to be more pathogenic than human. The quantity injected varied from 0.2 to 10 mg. Ocular lesions developed on the side injected and the majority of the animals developed pulmonary, hepatic and a more or less generalized tuberculosis which usually caused death, before the eye condition had run its full course. The average incubation period of ocular tuberculosis was a little over six days, the shortest being one day, and the longest thirteen. The first sign of disease was contraction of the pupil in the eye corresponding to the side which had been injected. Then came changes in the iris; in the more acute form, there were haemorrhages and a turbid aqueous. These changes were probably the reaction to an irritant, and were not specific. After the fourth day there developed "ridged iritis," wedge-shaped thickenings of the iris with their apices at the pupillary margin. Serous exudation occurred, and in severe cases greyish yellow nodules developed at the bases of the wedges, protruded into the anterior chamber and became vascularized. These nodules showed the histological picture of a typical tubercle. In the fulminating cases, the cornea was affected, becoming stippled, then dense white and later vascularized. Histologically, there was necrosis in the centre and inflammatory change in the periphery. This type of keratitis occurs after the injection of other substances which alter the nutrition of the cornea, and changes simulating the human type of tuberculous keratitis did not occur. Conjunctivitis occurred when the cornea was involved. Red and yellow nodules appeared, in some cases resembling phlyctens, which broke down to form small irregular ulcers. In nine smears out of 20, tubercle bacilli were found in the secretion. Episcleritis appeared in three animals after the fourteenth day. Choroiditis, when the condition of the media permitted ophthalmoscopic examination, ran a fairly typical course, ill-defined oval patches becoming yellow in colour, and later pigmented and circumscribed. Later still, the pigment moved to the periphery of the lesions, which themselves became brilliantly white. Histologically, there was first an infiltration with epithelioid cells, round a clump of bacilli, then small round cells appeared and the pigment epithelium showed signs of degeneration and proliferation. On disintegration of the retina, the pigment cells migrated forward. The last stage was caseation of the centre of the lesion with complete atrophy of the retina and disappearance of some of the pigment

in the centre. In most animals there was a severe generalized uveitis with clouding of the vitreous. Tubercle of the retinal vessels was observed in only one case, and appeared as a grey perivascular exudate. The presence of this was confirmed by histological examination which also showed endothelial proliferation in the veins. Finoff concludes that haematogenous eye infections with living tubercle bacilli are of a severe and progressive type and with a few exceptions do not correspond with human ocular tuberculosis. He also finds that dead tubercle bacilli can produce similar lesions, with this essential difference, however, that the lesions can be followed through their whole course, as the animal does not die from tuberculosis of other parts. Clump emulsions of bovine bacilli grown on glycerine agar and killed by boiling were injected into the common carotid artery in amounts varying from 0.2 to 10 mg. The size of the dose had no influence on the nature of the lesions or the frequency of infection. Early phenomena, due to irritation, occurred as in the series injected with living bacilli. Ridged iritis was not so common and, when it did appear, underwent retrogression, the iris returning to its normal condition or becoming atrophic. Synechiae and pupillary exudates were common. The iris nodules also occurred, becoming white about the sixth week and frequently discharging their contents into the anterior chamber; occasionally they fused, producing massive conglomerate tubercle. The smaller nodules were sometimes absorbed, leaving grey atrophic patches. The early changes in the cornea were similar to those observed in the first series, but, as the animals survived, it was possible to watch the disappearance of the vascularization. There was first a diminution of the fine peripheral vessels and the formation of a few large vascular trunks presenting arborescent branching. The periphery of the cornea then cleared gradually, leaving finally no trace of the vessels or only some fine strands of scar tissue. The later changes appeared after the eighth week. They comprised sclerosing keratitis beginning at the limbus, non-vascular lardaceous infiltrates in the substantia propria, and mutton fat precipitates. Conjunctivitis was seen similar to that in the first group and in one case a typical phlycten. In all except three severe cases the conjunctiva regained its normal appearance within ten days of the onset. In ten cases, nodules developed in the lids, which broke down to form crateriform ulcers; in one case a cold abscess formed. Episcleritis occurred once; it appeared on the seventh day, and lasted ten days. Tubercles of the choroid appeared as in the first series; they were always multiple and scattered irregularly over the fundus. A detailed account is given of their histological and ophthalmological changes. Vitreous haze developed in eight cases and cleared in a short time. One animal

developed a tubercle on the optic disc and in one there was an isolated tubercle on the retina. There was no case of tubercle of the retinal vessels.

F. A. WILLIAMSON-NOBLE.

(4) **Davids, H. (Münster).—On the use of bacillary emulsion in tuberculous and scrofulous diseases of the eye. (Weitere Mitteilungen über den Nützen der Bacillenemulsion bei den tuberkülosen und skrofülosen Erkrankungen des Auges.** *Arch. f. Ophthal.*, Vol. CXIV 1924.

(4) *Owing to the difference of opinion* still existing as to the value of tuberculin therapy in tuberculous diseases of the eye **Davids** *returns to the discussion of the subject* after twenty years' experience of this method of treatment, and cites a few of a series of cases including various types of this disease to show its efficacy, particularly in the form of bacillary emulsion. All these cases were treated with B.E. and atropin only, after a preliminary positive test with O.T., mostly ambulant and even as far as possible while continuing their work, with uniform success after other lines of treatment had failed. These results, together with those of other writers, prove beyond doubt the value of tuberculin, and especially of B.E., as a curative agent.

He regrets that doubt should still be cast on this method of treatment on the grounds that relapses may occur and that tuberculin in certain cases fails to effect a cure.

Relapses do occur, but the fact of their disappearance on repeating the course of tuberculin when the primary attacks had yielded to its use he regards as further proof of its specific action. Moreover, they are best avoided by continuing it after the case is clinically cured.

Failures in cases of true tuberculous disease, he says, are very few.

Tuberculin treatment gives the best results in iritis with formation of nodules seen in young individuals, in tubercular choroiditis, keratitis, and scleritis; it is good in most cases of severe iritis without nodules occurring in the later decades of life, and the recurring vitreous haemorrhages of young persons, while in the class of chronic quiet iridocyclitis it can only be used with great caution.

The author utters a warning against the use of mercury in these cases as often harmful, and against a too hasty iridectomy.

As to scrofulous affections he recommends the preliminary test with O.T. followed by B.E. to cases of severe phlyctenular disease, but in cases where the O.T. test has produced an intense local reaction he advises that treatment should be pursued with caution.

THOS. SNOWBALL.

(5) **Passow, A. (Munich). — Researches into the direct and photo-dynamic action of light on bacteria as a basis for light-therapy of bacterial eye diseases. (Untersuchungen über die Lichtwirkung und die photodynamische Wirkung auf Bakterien als Grundlage zur Lichttherapie bazillärer Augenerkrankungen.)** Part I, *Arch. f. Augenheilk.*, September, 1923, Part II, *Arch. f. Augenheilk.*, February, 1924.

(5) All the experiments in this exhaustive investigation were made on the staphylococcus pyogenes aureus. For the details of the skilful technique and the interesting and instructive experiments, which do not lend themselves to abstracting, the reader is referred to the originals which occupy no less than sixty pages of the *Arch. f. Augenheilk.*

As regards the direct action of light on bacteria **Passow's** findings are as follow:

1. Infra-red, red, yellow, and green rays even of high total intensity had no effect whatever on the staphylococci.

2. Of the blue, violet and ultra-violet rays of low intensity, the extreme ultra-violet rays between λ 300 and 250 $\mu\mu$ were by far the most effective.

3. In this stretch of the spectrum the quartz and ferro-carbon arc acted more intensively than the carbon-arc light.

4. The effects of light on the bacteria, on the photometer paper and on the thermopile were altogether different and bore no relationship to one another.

5. Therefore, the action of light on bacteria is specific and depends mainly on the capacity of the bacteria to absorb particular rays.

6. In general, sources of light whose rays are the most intensive in the spectral parts which are best absorbed by the bacteria will be the most suitable for their destruction.

7. Given good capacity of the bacteria to absorb a particular radiation, a low total intensity of this radiation suffices to kill them; but if their capacity for absorption is defective, even a considerably increased total intensity of the radiation is uncertain of success.

8. In light-therapy of infectious diseases of the eye without the aid of biological sensitization, on account of their richness in intense ultra-violet rays, the quartz and ferro-carbon lamps are preferable to the carbon-arc lamp, and whenever possible the extreme ultra-violet radiation from 300 $\mu\mu$ downwards should be used unfiltered.

The second part of the research concerns the photo-dynamic action on bacteria. The findings are:

1. The bacteria can, without harm to themselves, absorb stains,

2. For photo-dynamic action it is essential that the bacteria should be capable of absorbing the photo-dynamically effective substances.

3. All the stains that were non-toxic to the staphylococci and coloured them well were also photo-dynamically effective except toluylen-red and indigo-carmin.

4. "Rose bengal" was the best sensitizing substance for the staphylococci; phloxin came next. Diiod-fluorescein, eosin erythrosin and acid fuchsin also produced good photo-dynamic action. The other substances of this kind experimented with produced very weak effects.

5. With the help of rose bengal, the photo-dynamic action in the yellow and green regions of the carbon-arc lamp spectrum appears quicker than the direct action of light in the ultra-violet region of the spectrum from the same source of light and with diiod-fluorescein, eosin, erythrosin, phloxin and acid fuchsin as quickly as in the latter.

6. Through suitable sensitizing—especially with rose bengal—all the rays except red and infra-red could produce bactericidal action.

7. As no fluorescence was recognizable in the case of acid fuchsin, pending further investigation, photo-dynamic action without the manifestation of fluorescence appears possible.

8. Even with the long-waved rays of low intensity of the 110-volt quartz-light—although only after about two to three times longer exposure than with the 16-amp. carbon-arc lamp—a strong photo-dynamic action is attainable.

9. Both the direct and the photo-dynamic action of light on the staphylococci occurred in the absence of oxygen. Consequently the photo-dynamic action on bacteria may be regarded as (*a*) a sensitization, *i.e.*, accentuation of light-action; and (*b*) not dependent on a process of oxidation.

10. Whether or not sensitization of bacteria is a pure process of absorption requires further investigation.

From these two sets of findings the author derives the following conclusions:

(*a*) In the application of rays to bacterial diseases of the eye, sensitization with rose bengal, phloxin, diiod-fluorescein, eosin, erythrosin or acid fuchsin—the stains are given in the order of preference—is to be recommended, provided that the stain is equally photo-dynamically active against the bacteria to be killed as against the staphylococci and is harmless to the tissues of the eye. It has been found that rose bengal diffuses well through the cornea while being just as harmless to the eye as fluorescein which is photo-dynamically ineffective.

(*b*) Besides the short-waved rays which are in themselves bactericidal, by means of sensitization the more penetrating long-waved rays could also be rendered bactericidal, so that an appreciable summation of effect results.

(*c*) For the direct action of light the quartz and ferro-carbon lights are preferable to the carbon-arc light and for photo-dynamic effect the latter is superior to the former.

(*d*) With the reservations mentioned under (*a*), to obtain a harmless and effective light-therapy the employment of photo-dynamic action by means of the carbon-arc lamp is more suitable than the direct action of ultra-violet rays as: (1) the latter may damage the tissues of the eye; (2) by sensitization the bacteria could, to say the least, be as quickly killed by the yellow-green rays as by the ultra-violet; and (3) the long-waved rays penetrate deeper into the tissue than the short-waved, and thus hold out the possibility of killing bacteria even when deep-seated, as for example in the cornea.

D. V. GIRI.

(6) **Woodruff, F. E. (St. Louis)—Nocardia (streptothrix) infections.** ***Arch. of Ophthal.***, January, 1923.

(6) **Woodruff** notes that the nocardia are familiarly known as streptothrices, which is incorrect as there are marked differences between the two groups. Comparatively few cases have been recorded of infections with this type of organism, but it has been found in pneumonic areas, in cerebral abscesses and in meningitis. The lesions often resemble those produced by the tubercle bacillus. Microscopically, the organisms are curved and thread-like, the threads varying in length and thickness. The thicker ones show deeply stained globules and irregular bodies. Branching, which is only seen occasionally, is irregular, the branches being placed at a wide angle, sometimes at right angles. Nocardia would appear to occupy a position intermediate between certain of the bacteria and the hyphomycetes. Woodruff's case occurred in a girl, aged 19 years, who for six years had had a round circumscribed mass about 12 × 4 mm. under the skin of the left eyebrow. This was removed. During the operation the wall of the tumour was ruptured allowing a small quantity of pus to escape. The tissue removed showed many small lobules composed almost entirely of epithelioid cells with the thread-like organisms in compact groups at or near their margins. A small amount of tissue was left at the first operation and in consequence an abscess developed a week later which was opened and drained. The smears from this showed long and short threads of uniform thickness, with some branching. The appearances were quite different from those of the organisms in the tissue removed at the first operation.

F. A. WILLIAMSON-NOBLE.

(7) **Grüter, Wilhelm (Bonn).—The mode of propagation of the herpes virus in the animal body and its significance in the problem of sympathetic ophthalmitis. (Der Verbreitungsmodus des Herpesvirus im Tierkörper und seine Bedeutung für das Problem der sympathischen Ophthalmie.)** *Arch. f. Augenheilk.*, February, 1924.

(7) In this communication **Gruter** discusses the findings of v. Szily, Mariani, Dörr and Schnabel, Bastai and Busacca, v. Prowazek, Marinesco and Draganesco, Rehbock and himself, in experiments on rabbits with the virus of herpes.

It has been found that the propagation of the virus may occur either by the blood and lymph streams, or by the preformed nerve paths, or both. In the case of the nerve paths the spread may be either centripetal or centrifugal according as the initial site of infection is central or peripheral. In rabbits the virus shows a definite elective affinity to the nerve paths along which it spreads by continuity, though it is not improbable that to a small extent the blood stream is responsible for its propagation.

The anatomical investigation of animals which died of encephalitis after corneal inoculation has shown that the virus penetrates along the ciliary nerves into the ciliary ganglion, further into the Gasserian ganglion, and from there into certain seats of predilection in the brain: optic thalamus, hippocampus the nuclear region of the pons and medulla oblongata; it also spreads within the vascular layers of the meninges and the perineural sheaths of the optic nerve.

In some instances inoculation keratitis in the one eye was followed by spontaneous keratitis in the other. In one case in which the animal died of encephalitis after inoculation, an infiltrative perineuritis in both eyes extending to the chiasma was noted; in another, after subdural (not intracerebral) inoculation, encephalitis followed by a descending uveitis and keratitis occurred and, from the keratitis, inoculation into another animal proved positive.

These results inclined v. Szily to surmise some affinity between the herpes virus and that of sympathetic ophthalmitis and to hint at the possibility of sympathetic disease occurring by the passage of the virus from the one eye to the other by way of the chiasma.

The author differs from v. Szily. Neither v. Szily's experiments nor his own nor those of others support the view that the herpes virus or a virus biologically akin to it is the cause of sympathetic ophthalmitis. The mode of spread of the herpes virus is comparable to a septic infection of the brain by a visible germ. In man sympathetic ophthalmitis after superficial infection of the cornea does not occur. The migration theory of sympathetic ophthalmitis in man demands the spread of the herpes virus

exclusively by way of the optic nerves and chiasma and this condition is put out of court by its peculiar diffuse mode of propagation in the brain. Further, while the virus is mainly a neurotrope in the rabbit, it is an outspoken dermatrope in man. He gives credit to v. Szily for having shown the possibility of a spontaneous transmission of inflammation from the one eye to the other by the blood and nerve paths and agrees with Axenfeld that probably an invisible virus is the long looked-for cause of sympathetic ophthalmitis.

D. V. GIRI.

II.—MISCELLANEOUS

(1) **Howard, Harvey, J. (Peking).—Rôle of the epithelial cell in conjunctival and corneal infections.** *Amer. Jl. of Ophthal.*, December, 1924.

(1) This important paper by **Howard,** covering 26 pages and illustrated with 18 microphotographs will be of great interest to all who are concerned with the bacteriology of conjunctival infections. The first four pages are concerned with details of technique—space does not allow of their being transcribed in full. Scrapings were taken with a sterile platinum spatula from the palpebral conjunctiva and with a slightly dull discission knife, from the bulbar conjunctiva and cornea of numerous cases of conjunctivitis—the eyes being previously anaesthetized with cocain. Smears were also made from the conjunctival secretion. The scrapings included epithelial cells, so that the relationship between these and the infecting organisms could be made out. When it was desired to know what was taking place in the tissue as a whole, a small piece of conjunctiva was removed by squeezing down a pair of de Wecker scissors over it and cutting off the tissue between the blades. The staining was done principally with Lindner's contrast stain and both dry and wet fixation were used for the specimens examined.

At the outset, Howard emphasizes the fact that all the cells in the epithelium of a mucous membrane, such as the conjunctiva, are alive, in contrast to the epidermis of the body generally, where the superficial cells are dead. Hence organisms which are found growing on the epithelial cells of the conjunctiva are to be regarded as parasites, while those which grow only on the desquamated cells are saprophytes. It is interesting to note that of the bacteria, only the gonococcus, pneumococcus, b. Koch-Weeks, b. diphtheriae and b. influenzae can be regarded as parasites, staphylococcus, b. xerosis, etc., being only saprophytes. The bacillus of Morax

and Axenfeld while it grows as a saprophyte, yet produces an exogenous toxin which causes an irritative conjunctivitis. Taking the parasitic organisms: The gonococcus. Smears made immediately after a definite infection with gonorrhoeal discharge show the presence of the organism; a few hours later however none can be found. If, 24 hours later, scrapings are taken from the areas showing commencing inflammation, turfs of gonococci are seen on the surface of some of the epithelial cells, though none can be found in a smear. In 36 to 48 hours the turfs of growth are more extensive and, when they cover several cells, the most extensive concentration of germs occurs at the cell boundaries. Even at the end of the third or fourth day the gonococci found in smears are scanty while vast numbers of them are seen in epithelial scrapings. From the fifth to the tenth day, the superficial cells are found to be smaller and more cylindrical in shape, because the old flattened cells have been thrown off and those replacing them have only recently been derived from the basal cells. At the third day the gonococci dissolve the intercellular cement substance, penetrate the superficial epithelial layer at the cell borders and begin to grow on the posterior surface of these cells. They seldom penetrate beyond the deepest epithelial cells, though in some cases the whole conjunctiva is thrown off in certain areas, leaving only a few firmly attached basal cells. Phagocytosis occurs in the epithelial cells at the end of the first week, and is most active between the tenth and fourteenth days. Ten to twenty organisms are usually present in each cell, and they can be seen undergoing various stages of degeneration and digestion, down to the stage at which the organism is represented by a little area of cloudy granular material. In no case was a leucocyte found in the conjunctiva, acting as a phagocyte of gonococci, *i.e.*, they are effective only against germs which have been torn loose from their living hosts, the epithelial cells, and are lying in the secretion. Leucocytic phagocytosis of gonococci begins at the end of the first week. The density of growth on the corneal epithelium was about half that found in conjunctival specimens removed at the same time. Where there is an ulcer, gonococci are found in the surrounding epithelium, but in the substance of the ulcer there are only a few free ones, mixed with the detritus. There is no evidence of the proliferation of gonococci in the substance underlying the ulcer.

The pneumococcus: Proliferation occurs first on the bulbar conjunctiva, then on the palpebral; the process is rapid and reaches its maximum on the second day. Penetration does not occur below the third layer of cells and epithelial phagocytosis is well under way by the second day. Leucocytic phagocytosis is a very minor process. Scrapings from the cornea on the second day show an astonishing number of germs though the clinical appearance

is not abnormal. On the third day, the scrapings from cornea and conjunctiva are negative and the disease has disappeared by crisis. Pneumococcic ulcers rarely begin with pneumococcic conjunctivitis, but in ulcus serpens the organisms are found in the substance of the cornea beneath the ulcer. In the new born, pneumococcic infections are more persistent.

Koch-Weeks infections follow much the same course as those due to pneumococci; the infection is at a maximum on the second day, declines considerably on the third day and by the fourth day the scrapings are negative, though from time to time during the following three weeks small tuft growths are found in the scrapings.

B. influenzae differs from Koch-Weeks in the slightness of its proliferation and the shallow depth to which it penetrates, though the secretion contains an abundance of bacilli. In diphtheria, epithelial cell phagocytosis was not observed.

In acute trachoma and inclusion blenorrhoea, Lindner's contrast stain showed the presence of small epithelial cell inclusions of "initial bodies" about the end of the first week. They appear as dark blue cocci-like bodies. Some are also found lying free, but to bring these out well Giemsa's stain is required; they are present in all stages of division and in a great variety of sizes. In the cells, the most prominent inclusion generally covers the nucleus at one end like a cap, in more advanced stages the entire protoplasm of the cells may be filled with blue initial bodies. Later, they are found to stain a pink colour and are then called elementary bodies. In some cells the bodies can be seen in the act of being extruded through a gap in the cell wall. Morphologically they are identical in inclusion blenorrhoea and trachoma, both acute and chronic, though in the latter they are far less numerous. In one case of mixed infection, epithelial cells were found with gonococci on the surface and inclusion bodies inside. Two cases of spring catarrh were examined; in the first, of pericorneal type, with pavement stone granulations on the palpebral conjunctiva, a few were found. B. Morax-Axenfeld was found only on dead epithelial cells which were present in greatest amount on the lid margins or at the canthi. The same was true of b. xerosis and staphylococcus, but there was no sign of any irritation being caused by either of them. The pneumococcus, though it can act as a parasite is more frequently found as a saprophyte growing on dead cells or shreds of mucus, and producing no irritation. It was found present as a saprophyte in 40 per cent. of normal individuals; the reason why it should suddenly become parasitic is not known. With regard to saprophytes in general, the toxins of b. xerosis and staphylococcus exert a non-pathogenic rôle and only that of the diplobacillus is pathogenic. They are never phagocytated by epithelial cells, and by leucocytes only after an acute conjunctivitis due to

one of the pathogenic organisms. With the parasitic organisms, proliferation usually begins on the bulbar conjunctiva and extends rapidly over its surface and over the cornea by the creation of many separate foci. The proliferation then extends more slowly over the palpebral conjunctiva. The bacteria disappear from the bulbar area by crisis, whereas turfs of them may be found growing here and there on the palpebral conjunctiva for quite a long time. Several factors are concerned in bringing about the disappearance of the organisms.

1. The ectotoxins produce a dissolution of the intercellular cement substance, and so breaks occur in the superficial epithelial layer of the conjunctiva through which the bacteria grow. This dissolution continues until all the epithelial layers are affected, but at the same time, an abnormal proliferation occurs, the superficial cells with their dense turf being cast off. Layer after layer of cells is removed until in a very few days the conjunctiva is composed of entirely new cells which are actively phagocytic and digest the bacteria. This was proved microscopically and it is interesting to note that whereas the germs can thrive parasitically on the surface of the epithelial cells, once they are inside they become digested and broken up.

2. The ectotoxins cause subconjunctival hyperaemia and oedema, with formation of pus cells. These act merely as "camp followers" and act only against bacteria which are no longer parasites, *i.e.*, against those which have been cast off and washed into the secretion. Not a single leucocyte was found showing phagocytosis in all the wet-fixed specimens of conjunctival tissue.

The cornea, though covered with the same kind of bacteria which are so toxic for the conjunctiva, showed no clinical symptoms whatever. The explanation is probably three-fold: (1) In the absence of blood-vessels sudden and active proliferation of the deeper epithelial cells does not occur; (2) the cells being less "viable" react to all external injuries and stimuli in much slighter degree; (3) the cells being dryer and flatter, are less nutrient and the germs disappear from lack of nutrition. No epithelial cell phagocytosis was observed in the cornea. When an ulcer occurs, except in gonococcal ophthalmia and ulcus serpens, it is due to some trauma producing a breach in the epithelium. Discussing the findings in trachoma, Howard notes that the difference between the parasitic rôles of inclusion bodies and bacteria, is that the former proliferate in the substance of the cells, the latter on their surface. These bodies are not derived from nuclear material, because with Lindner's stain they are dark blue, as are the bacteria, while the nuclei and cell protoplasm are not stained blue at all. Moreover, cellular degeneration bodies do occur in various forms of conjunctivitis including trachoma, but they are not stained blue

by the contrast method. Hence bacteria and initial bodies are closely allied and have a biologic similarity; Noguchi and Cohen were able to cultivate them. In wet-fixed specimens they are seen on the periphery of spaces containing fluid, sticking to the cytoplasm and feeding on it. The degree of proliferation is in direct proportion to the amount of available protoplasm, and when this is all consumed they break through their thin cell wall and other cells as yet unaffected take them in. From some cells, however, the initial bodies appear to be unable to escape so that they remain within their host and die. Other types of so-called cell inclusions such as molluscum contagiosum, vaccinia, herpes, etc., are cellular reaction products, and not true inclusions.

In his summary Howard notes that the following factors are concerned in terminating infections of the conjunctiva: (*a*) The early casting off of the superficial layer with its dense turf of bacteria; (*b*) the out-pouring of exudates against whose current the bacteria must grow; (*c*) extensive proliferation of the deeper cells, which results in continuous exfoliation of cells, as layer by layer the deeper ones become superficial; (*d*) phagocytosis by the epithelial cells of the deeper layers; (*e*) a local acquired immunity where the toxins have stimulated the generation of an entirely new conjunctival structure.

F. A. WILLIAMSON-NOBLE.

BOOK NOTICES

Pathology and Bacteriology of the Eye. By E. TREACHER COLLINS and M. STEPHEN MAYOU. London: Wm. Heinemann, Ltd. 1925. Second edition. With 4 coloured plates, several coloured illustrations in the text and 306 figures. Price 42s.

The first edition of this book was published thirteen years ago as a volume of Pyle's "System of Ophthalmic Practice." The present work is produced independently. It is a welcome revision of a well-known and useful book. It has been considerably enlarged by about one hundred and eighty pages and now contains seven hundred and thirty pages. The number of illustrations has also been increased considerably, from two hundred and thirty-seven to three hundred and six. The coloured illustrations in the text are a new feature. Some are good, viz.: Fig. 112, angioma of the conjunctiva, and Fig. 194 of subhyaloid haemorrhage in pathological section, but Fig. 288 has not been reproduced at all well and shows hardly any trace of the reticular opacity of the cornea,

and furthermore, the colour of the eyelids and the eyeball is decidedly poor.

The greatest additions to the book occur in chapters III, V and VII. Chapter I also has a number of fresh subjects: megalocornea and microcornea; astigmatism, keratoconus, blue sclerotics, lateral proboscis or demicyclops, enophthalmos, heterophoria, and concomitant squint. In the latter, although reference is made to the defect of vision common in the squinting eye—as due usually to congenital amblyopia, corneal nebulae, refractive error or intraocular affection—no mention is made of the importance of "amblyopia ex anopsia" or disuse amblyopia, although the term *in inverted commas* appears in the index against page 156. The chapter on glaucoma and on the intraocular circulation has been considerably enlarged, and references are given to some of the recent work.

On pages 321 and 322, an obvious misprint occurs. Reference to damage to "superior external arcuate fibres" at the edge of the glaucoma cup with loss of "the lower *temporal* part of the field" should read "lower *nasal*," and similarly "inferior external arcuate fibres . . . . upper *temporal*" should read "upper *nasal*." This is of such great importance that the publishers will doubtless insert a slip in the page concerned. Elsewhere, displacement of the retinal vessels to the nasal side of the disc in early stages of glaucoma is explained as being "due to stretching of the posterior pole of the globe causing traction on the retina." Surely traction on the retina to the temporal side of the disc would be expected to draw the vessels more over to the temporal side of the disc. If on the other hand, stretching were more on the nasal side of the disc, it might occur, but there would seem to be no evidence of this. Apart from the above mistake and the debatable theory referred to, this section makes particularly good reading. The chapter on glaucoma has been nearly doubled, from sixty to one hundred pages. The new section on hypotony contains a number of excellent fresh illustrations of microscopic sections. Additions to chapter V, on inflammation, include paragraphs on various subjects, *e.g.*, hypersusceptibility, sensitization, idiosyncrasy to drugs. Reference is made here to the hypersensitiveness of certain persons to soft lens matter. It is interesting to note that the use of milk injections in the treatment of ophthalmia neonatorum proved very far from satisfactory. Chapter VII has several alterations and additions, and includes a description of the pathology of symmetrical macular pigmentary degeneration, among others. It would not have been out of place to have included under Fig. 232, page 463, the term "keratic precipitates" in addition to or in lieu of "keratitis punctata" for "K.P." On page 333, section V, "affects" should read "effects."

A very great improvement is to be noted in the index. In the old edition a number of references were absent. The new index is increased to twelve pages from seven, and seems to be very complete. The type is of the same size as in the first edition; the paper is of excellent quality, possibly even superior to that of the former, so that all the illustrations have the best opportunity of appearing to good advantage.

This book undoubtedly fills a deeply-felt need. There is no other textbook in the English language that is more suitable to the student of ophthalmology on the subject of pathology of the eye.

The Ophthalmic Year Book. Vol. XXI. Containing Bibliographies, Digests and Indexes of the Literature of Ophthalmology for the year 1924. Edited by William Crisp. Pp. 323 with 10 text illustrations. Chicago: The Ophthalmic Publishing Co. 1925.

This invaluable volume has now settled down to its regular form and arrangement. The lists of "Current Literature," which appear monthly in the *American Journal of Ophthalmology*, furnish almost the entire basis for the bibliographic lists, and the digests of which the Year Book is made up. The editor gratefully acknowledges the considerable self-sacrifice of his numerous collaborators, without which the issue of the volume would not be possible.

In the present volume an effort has been made to economize space by the omission of references which, although they may be of interest in current reading, possess little or no permanent value. It has also been found necessary to enlarge the chapter on "Comparative Ophthalmology" so as to include the references for two years.

The volume is essential to all who wish to keep abreast of the literature of the subject, and the arrangement renders reference very easy. We feel justified in saying that it is the duty of all ophthalmic surgeons to support such a valuable publication by becoming subscribers.

Ocular Therapeutics. By Dr. ERNST FRANKE, Hamburg. Translated by Dr. Clarence Loeb, Chicago. St. Louis: The C. V. Mobsby Co. London: Henry Kimpton. Pp. 183. Price 18s.

The German original of this volume was duly noticed in our columns on its appearance last year (*Brit. Jl. of Ophthal.*, Vol. VIII, p. 301, 1924). The translator has done his work conscientiously and well, and has, therefore, failed to remove the faults we pointed out in the original. The chief of these were the very uncritical nature of the work and the introduction of the names of synthetic preparations which, though possibly familiar to German-speaking nations, will certainly not be so to English readers.

NOTES

Deaths

THE death of PROFESSOR J. N. LANGLEY, F.R.S., Professor of Physiology at Cambridge, is a loss to ophthalmology as well as to physiology. His lifelong work on the autonomic nervous system contributed many new facts of profound importance to the physiology and pathology of the eye. Of outstanding interest in this respect were his researches on the ciliary ganglion and the superb investigation carried out by him and Sir Kenneth Anderson on the iris, which set at rest the long controversy as to the existence of a dilatator pupillae muscle.

We regret to announce the death of DR. PERCY CROFTS BARDSLEY at his residence in The Close, Salisbury, early in the morning of November 12, in his 60th year. He was educated at Cambridge University and University College Hospital; B.A., 1888; L.S.A., 1891; M.A., M.B., B.Ch., Cantab., 1896. Practising in Salisbury and at 67, Wimpole Street, he was ophthalmic surgeon to the Salisbury Infirmary and to the Willesden Hospital. For many years he was one of Mr. Marcus Gunn's chief clinical assistants at Moorfields, and on Mr. Gunn's death in 1909, he contributed an eloquent appreciation of his old chief to the columns of the *Lancet*.

He was an occasional contributor to our columns and to the Transactions of the Ophthalmological Society of the United Kingdom. His scotometer and needle-holder are well known.

He had been far from well for the past year, but was able to keep at work until about a fortnight before the end.

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Appointment

MISS IDA C. MANN has been appointed Pathologist to the Central London Ophthalmic Hospital.

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Corrigenda

IN Mr. Sack's contribution to the discussion on Miners' Nystagmus, published in our last issue, on page 570, the following corrections should be noted: L.8. omit "or half-watt." In the penultimate paragraph substitute "Osram Lamp works" for "research laboratories."

Course on Slit-Lamp Microscopy of the Living Eye

A COURSE upon the use of the slit-lamp is to be given at the Oxford Eye Hospital on December 18 to 22 inclusive. The Course, which will be under the general direction of Mr. P. H. Adams, Reader in Ophthalmology at Oxford University, will be on the same lines as that given last year. The lectures will be given by Mr. Harrison Butler. Owing to the kindness of Messrs. Zeiss, the necessary slit-lamps will be at the disposal of the Eye Hospital.

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The Middlemore Prize

THIS prize for 1925 has been awarded to Mr. Basil Graves.

FUTURE ARRANGEMENTS

1925

December 4.—North of England Ophthalmological Society at Bradford.

December 11.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

1926

January 8.—Royal Society of Medicine, Section of Ophthalmology.

February 5.—North of England Ophthalmological Society at Liverpool.

February 12.—Royal Society of Medicine, Section of Ophthalmology.

March 5.—North of England Ophthalmological Society at Sheffield.

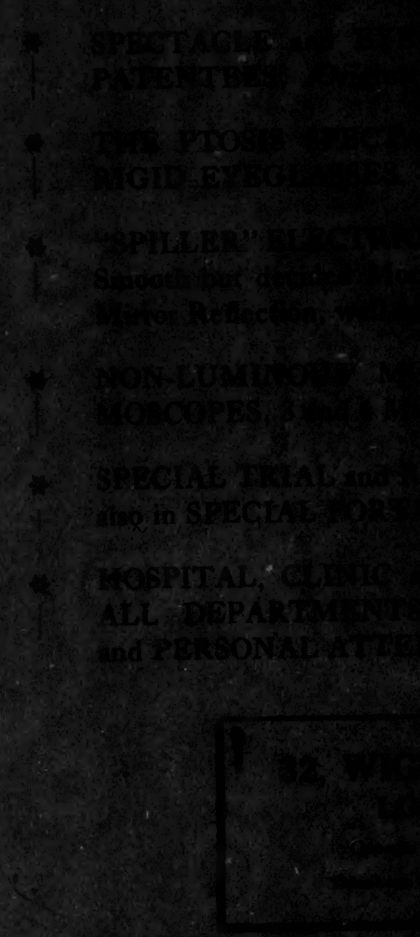
March 12.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

April.—North of England Ophthalmological Society at Newcastle.

May 14.—Royal Society of Medicine, Section of Ophthalmology.

June 11.—Royal Society of Medicine, Section of Ophthalmology (Annual).

GEORGE
Surgeon


SPECTACLE
PATENTEES
TYPE PTOSIS
RIGID EYEGLASSES
"SPILLER" ELECTRO
Smooth but decided
Mirror Reflection,
NON-LUMINOUS
MOSCOPES, 3
SPECIAL TRIAL
also in SPECIAL
HOSPITAL, CLINIC
ALL DEPARTMENTS
and PERSONAL ATTEN

$2